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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ : B60G 17/056	A1	(11) International Publication Number: WO 95/29823
		(43) International Publication Date: 9 November 1995 (09.11.95)

(21) International Application Number: PCT/US94/04862

(22) International Filing Date: 3 May 1994 (03.05.94)

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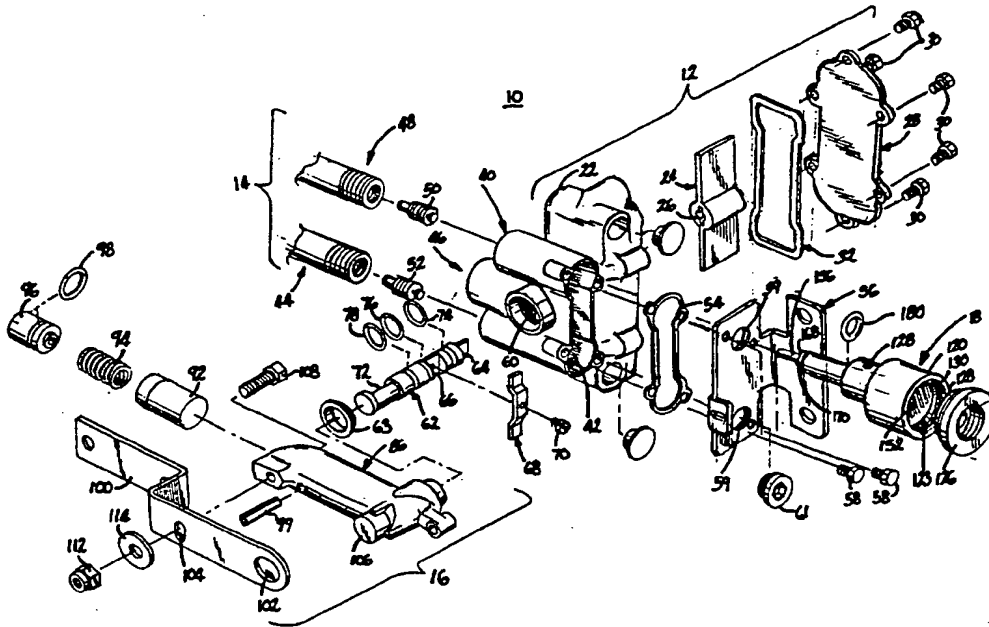
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(81) Designated States: AT, AU, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, ES, FI, GB, HU, JP, KP, KR, LK, LU, MG, MN, MW, NL, NO, PL, RO, RU, SD, SE, SK, US, VN, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published

With international search report.

(54) Title: HEIGHT CONTROL VALVE WITH DUMP VALVE



(57) Abstract

A height control valve (10) for an air spring suspension maintains the vehicle frame at a predetermined height by exhausting or adding pressurized air to the air springs of the vehicle suspension in response to a sensor (16) that measures the position of the vehicle frame relative to a suspension member. A dump valve (18) is mounted to the height control valve so that the air springs may be completely exhausted of pressurized air when desired. The dump valve also prohibits the addition of pressurized air to the air springs when the dump valve is actuated.

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HEIGHT CONTROL VALVE WITH DUMP VALVE

Background of the Invention

Field of the Invention

5 This invention relates to a height control valve in a vehicle suspension and, more particularly to a height control valve with a novel dump valve. In another of its aspects, the invention relates to a dump valve for a height control valve.

State of the Prior Art

10 Air suspension systems have become increasingly popular for use in vehicle suspensions, seats and cabs on semi-trailer truck rigs and other vehicles. Most air suspensions typically employ a height control valve that maintains the design height of the suspension. In a semi-trailer suspension, for example, the design height is the spacing between the frame and the axle. The height control valve senses when the spacing is greater or less than its
15 design value and, accordingly, adjusts the pressure in the air springs disposed between the frame and axle, which expands or contracts the air spring to alter the spacing between the suspension and the frame. The air suspension system with a height control valve maintains a uniform spacing of the air spring and frame over a range of vehicle loading conditions.

20 The height control valve adjusts the spacing by selectively admitting fluid into, or exhausting fluid from, a height control member, which is typically an air spring. In a trailing arm suspension, the air spring is positioned between the vehicle frame and the trailing arm. The trailing arm carries the axle so that adjusting the air spring pressure also adjusts the
25 distance between the vehicle frame and the axle. The height control valve typically mounts on the vehicle frame and has a control arm that connects to the trailing arm through a linkage. As the distance between the vehicle frame and trailing arm varies, the linkage causes the control arm to rotate a control shaft extending into the height control valve, which, in turn, selectively permits
30 air to be admitted to or exhausted from the air spring depending on which way the control arm rotates.

35 Typically, the height control valve has three ports: an air spring port connected to the air spring, an inlet port connected to a source of pressurized air, and an exhaust port open to the atmosphere. To increase the height of the air spring, the height control valve opens fluid communication

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between the air spring port and the inlet port, allowing air to flow from the pressurized air source, through the height control valve and into the air spring. To decrease the height of the air spring, the height control valve opens fluid communication between the air spring port and the exhaust port, allowing air to flow out of the air spring through the height control valve, into atmosphere through the exhaust port. When the air spring is at the proper height, the valve is in a neutral position wherein neither the inlet port nor the exhaust port communicates with the air spring.

There are generally two types of height control valves: an instant-response height control valve and a time-delayed height control valve. An instant-response height control valve is directly connected to a sensor, such as a mechanical linkage, that detects the position of the frame with respect to the trailing arm. The instant-response height control valve will respond immediately to any change in the position of the frame with respect to the trailing arm to add or exhaust pressurized air from the air springs without delay. Hence, such height control valves are actuated by discontinuities in the road surface, such as tar strips or pot holes and a change in the plane of the vehicle relative to the road surface during turning.

In many applications it is undesirable for the height control valve to respond immediately to road surface discontinuities or other rapid fluctuations in the height of the vehicle relative to the suspension. In such applications, a time-delayed height control valve is preferred. The time-delayed height control valve is linked to the frame in such a manner that there is a delay in the response of the height control valve to a variation in the height of the frame. Such a height control valve is disclosed in U.S. Patent Nos. 4,726,571, issued February 23, 1988, 3,858,903, issued January 7, 1975 and 3,884,454, issued May 20, 1975. The height control valve disclosed in these references comprises a spring-biased, mechanical linkage that is dampened so that as the vehicle height is altered, the height control valve will not actuate until the linkage moves a predetermined distance for a predetermined amount of time controlled by the physical structure of the linkage, spring bias and the dampening element.

Frequently, dump valves are added to vehicles equipped with air suspensions to selectively "dump" or exhaust air from the air springs and lower the vehicle chassis height. A common application for dump valves on tractors

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permits air to be selectively exhausted from the tractor suspension so that the tractor can be connected to or disconnected from a trailer. In disconnection, for example, the operator typically lowers the front dolly legs on the trailer until they touch the ground. The gear mechanism on the dolly legs is manually operated and thus easier to turn with no load on the legs. Instead of manually working the gear mechanism under load further to raise the trailer, air is "dumped" or exhausted from the tractor air springs, thereby lowering the tractor frame and shifting the trailer weight to the dolly legs. The tractor is then free to separate from the trailer.

Another application for dump valves is to adjust the vehicle frame height on trailers during loading conditions. A condition known as trailer creep sometimes occurs as a trailer is loaded adjacent a loading dock. If the height to the trailer is not controlled during loading, the increasing load in the trailer will sometimes cause the trailer tires to rotate about the ground contact point and force the trailer forward away from the dock. In other words, the trailer tends to "walk" away from the loading dock. This tendency presents obvious problems with strain levels on the trailer dolly legs and access to the trailer from the dock. Thus, it is desirable to exhaust (dump) all the pressurized air out of the air springs before loading the trailer.

Typically, prior art dump valves used to exhaust air from air springs are separate mechanisms that must be positioned and mounted on the vehicle and separately plumbed into the air lines. The additional labor and hardware costs often exceed the cost of the dump valve and increase the time for vehicle assembly.

Another problem associated with dump valves used especially in conjunction with certain types of time-delay height control valves is that during actuation of the dump valve, the height control valve may not fully seal the inlet port at the same time. Thus, pressurized air may be exhausted unnecessarily which also adversely affects the rate of air spring exhaustion.

Summary of Invention

The present invention provides a dump valve that is mounted directly to a height control valve and prohibits the height control valve from pressurizing the air springs as the air is exhausted from the air springs. The height control valve comprises a housing mounted to the frame and having an interior chamber. The height control valve further has an inlet port, discharge

port and device port. The inlet port is adapted to fluidly connect to the interior chamber with a source of pressurized fluid. The discharge port is adapted to fluidly connect the interior chamber with the atmosphere. The device port is adapted to fluidly connect the interior chamber with a height control member, which is mounted between the frame and the suspended member. Preferably, the height control member is expandable by pressurized fluid. The height control valve has a sensor that is operably connected to the suspended member and senses a change in the height of the frame relative to the suspended member. The sensor is operably connected to a controller disposed within the housing, and which prohibits fluid communication between the device port and the inlet port and discharge port when the frame is at the design height. The controller also places the device port into fluid communication with the inlet port when the sensor senses a height less than the design height. The controller further places the device port into fluid communication with the discharge port when the sensor senses a height greater than the design height. A dump valve is also mounted to the housing and has a fluid port connected to the interior chamber of the housing and to the atmosphere. A valve element is disposed in the fluid port and is selectively movable between a sealed condition in which the interior chamber is sealed from fluid communication with the atmosphere through the fluid port and an exhaust condition in which the housing interior chamber is in fluid communication with the atmosphere.

Preferably, the valve element is a piston movably mounted within the fluid port for reciprocating movement between a first position where the dump valve is in the sealed position and second position where the dump valve is in the exhaust condition. The dump valve can have a trigger for moving the piston between the first and second positions. The piston includes a head mounted to a rod with the head disposed within the fluid port and the rod extending from the fluid port into the interior chamber through an inlet opening in the dump valve. A seal is fixedly mounted to the rod to seal the dump valve opening in the fluid port with respect to the housing interior and to fluidly connect the fluid port with the housing interior during actuation of the piston. When the fluid port is fluidly connected with the housing interior, the piston rod prohibits the controller from fluidly connecting the inlet port to the device port.

In one aspect of the invention, the piston can be moved between a first and second position to place the dump valve in a sealed condition or an exhaust condition. A spring can be used to resist the movement of the piston from the first and second positions. Alternatively, a spring can be used to urge the piston from the first to the second position. The piston prohibits air from the inlet port from entering the interior chamber of the height control valve when the valve is in the exhaust condition.

In another aspect of the invention, the dump valve has a dump valve inlet port fluidly connecting the fluid port to the housing interior and the dump valve inlet port is on one side of the height control valve housing and the inlet port and the device port are on the other side of the inlet housing.

In yet another aspect of the invention, the height control valve can be a time-delay valve.

Brief Description of the Drawings

The invention will now be described with reference to the drawings wherein:

FIG. 1 is an exploded view of a height control valve and dump valve assembly according to the invention;

FIG. 2 is a sectional view of the assembled spring return assembly of FIG. 1;

FIG. 3 is a sectional view of the height control valve of FIG. 1 with the dump valve in the sealed position;

FIG. 4 is a sectional view of the height control valve of FIG. 1 with the dump valve in the exhaust position;

FIG. 5 is a sectional view of a second embodiment of the height control valve with the dump valve shown in the neutral position;

FIG. 6 is a sectional view of the height control valve of FIG. 5 with the dump valve shown in the exhaust position; and

FIG. 7 is a sectional view of a third embodiment of the height control valve with the dump valve shown in the neutral position.

Description of the Preferred Embodiments

Referring now to the drawings and to FIG. 1 in particular, there is shown a height control valve 10 of the type that is described in U.S. Patent Nos. 3,858,903, 3,884,454 and 4,726,571, the substance of each of which is incorporated herein by reference. The height control valve 10 of the present

invention is similar in all respects to the height control valve disclosed in these three patents with the addition of the dump valve, which is described in detail.

Generally, the height control valve 10 comprises a damping assembly 12, an air control assembly 14 and a rotatable spring return assembly 16. A dump valve assembly 18 is fixedly mounted to the air control assembly 14. The air control assembly 14 is adapted to be mounted to a vehicle frame or chassis (not shown) and controls the flow of air into and out of the height control valve. The spring return assembly 16 is adapted to be operatively connected to a suspension member (not shown), such as a trailing arm movably suspended from the vehicle frame. In the typical suspension, an air spring is disposed between the suspension member and the frame to resist vertical displacement of the suspension member relative to the frame. It is to be understood that in some applications, the air control assembly will be mounted to the suspension member while the spring return assembly will be operatively connected to the frame.

The spring return assembly is rotatably mounted to the air control assembly 14, but with vertical displacement of the vehicle frame with respect to the suspension member, the spring return assembly 16 is rotated with respect to the air control assembly 14. With such rotation beyond a predetermined distance, the air control assembly 14 will add air to or exhaust air from the air spring in order to maintain the frame at a predetermined design height relative to the suspension member. The damping assembly 12 dampens the response of the air control assembly 14 to such movement, and comprises a damping housing 22 that defines a damping chamber (not shown) in which is received a damper vane 24 having a key slot 26. A base plate 28 is mounted to the damping housing 22 by screws 30 to enclose the damping chamber. Preferably, an elastomeric seal 32 is disposed between the damping housing 22 and the base plate 28 to fluidly seal the damping housing 22 and damping chamber. The damping chamber is filled with a relatively viscous fluid to resist movement of the damper vane 24.

The air control assembly 14 comprises an air control housing 40 that defines an air control chamber 42. The air control housing further comprises an inlet port 44, air spring port 46 and outlet port 48. The inlet port 44 is adapted to be fluidly connected to a source of pressurized air (not shown), such as the vehicle's air pressure system (not shown). The air spring

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port 46 is adapted to be fluidly connected to the air springs (not shown). The outlet port 48 is fluidly connected to the atmosphere. The inlet port 44 and the outlet port 48 both have valves 52 and 50 respectively, such as a dill valve with a stem, disposed therein. The air control chamber 42 is enclosed by gasket 54, which is compressively mounted to the air control housing 40 by mounting bracket 56 and screws 58. The mounting bracket 56 is used to mount the height control valve 10 to the vehicle frame, preferably, or other component of the vehicle chassis. Tapped apertures 59 extend through the mounting bracket 56 and are used to mount the dump valve assembly 18. Only one of the tapped apertures 59 is used to mount the dump valve assembly 18. The other tapped aperture will be plugged by plug 61. The two tapped apertures 59 provide for the height control valve to be either right or left-handed. The air control housing 40 also has an annular opening 60 through which a shaft 62 extends. A dust shield 63 is disposed in the annular opening 60.

The shaft 62 extends through the air control housing 40 and into the damping housing 22. The shaft 62 has a key 64, which is inserted into the key slot 26 of the damper vane 24. The shaft 62 further has a recessed portion 66 in which is mounted an actuator 68 by screws 70. A spring cup recess 72 is formed in the shaft 62. A series of O-rings 74, 76 and 78 are disposed in annular grooves formed in the surface of the shaft 62. The O-ring 74 fluidly seals the damping assembly 12 with respect to the air control assembly 14. The O-ring 76 fluidly seals the air control assembly 14 with respect to the atmosphere. The O-ring 78 fluidly seals the spring return assembly with respect to the atmosphere.

Referring now to FIGS. 1 and 2, the spring return assembly 16 comprises a spring chamber block 86 having a transverse bore 88 and an intersecting longitudinal bore 90 (FIG. 2). The spring chamber block 86 is rotatably mounted to the air control assembly 14 with the upper end of the shaft 62 received within the transverse bore 88. A partially hollow spring cup 92 is received within the longitudinal bore 90 and is positioned so that the end of the spring cup 92 is disposed within the spring cup recess 72 of the shaft 62. A spring 94 is partially disposed within the hollow interior of the spring cup 92. The spring 94 and spring cup 92 are retained within the longitudinal bore 90 by a plug 96 that seals the longitudinal bore 90. With the plug 96 disposed

in the end of the longitudinal bore 90, the spring 94 is compressed between the plug 96 and the spring cup 92. Preferably, an O-ring 98 is mounted to the plug 96 to fluidly seal the spring block chamber 86 with respect to the atmosphere. The plug 96 is retained with respect to the spring chamber block 86 by a pin 99 extending through the spring chamber block 86 and the plug 96.

The spring return assembly 16 further comprises a lever arm adjustably mounted to the spring chamber block 86. The lever arm 100 has a circular opening 102 and an elongated opening 104. A circular protrusion 106 extending from the spring chamber block 86 is received in the circular opening 102 of the lever arm while a bolt 108 extends through an opening 110 of the spring chamber block 86 and the elongated opening 104 of the lever arm 100 with a nut 112 and washer 114 to fixedly and adjustably mount the lever arm 100 to the spring chamber block 86. To adjust the position of the lever arm, the nut 112 is loosened and the lever arm is pivoted about the circular protrusion 106 within the range of the elongated opening 104 until the desired position is reached and the nut 112 is then tightened.

Turning to FIGS. 3 and 4, the dump valve assembly 18 comprises a dump valve housing 120 defining a dump valve chamber 122 having a trigger opening 123 and an inlet opening 125. A piston 124 is disposed within the dump valve chamber 122 and reciprocates within the chamber between a first position where the air control chamber 42 is sealed with respect to the dump valve chamber 122 (FIG. 3) and a second position where the air control chamber 42 is fluidly connected to the dump valve chamber 122 (FIG. 4). A piston trigger 126 is mounted to the dump valve housing 120 and serves to enable reciprocal movement of the piston 124. Preferably, the dump valve housing 120 has one or more ports 128 that fluidly connect the dump valve chamber 122 to the atmosphere. Further, one end of the dump valve housing 120 is preferably threaded at 130 so that the dump valve assembly 18 can be threaded into the tapped aperture 59 in the height control valve bracket cover 56.

The dump valve chamber 122 has a stepped profile which generally conforms to the shape of the piston 124. More specifically, the dump valve chamber 122 comprises a series of sequentially decreasing diameter portions. Initially, the outer portion 132 of the dump valve chamber 122 is defined by threads 134 adjacent the trigger opening 123. The outer

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portion 132 abuts a central portion 138, which terminates in an annular stop 140. Extending from the annular stop 140 is a shaft portion 142 that terminates at an annular ledge 144. A stem portion 146 of the dump valve chamber 122 extends from the annular ledge 144 to the inlet opening 125 of the dump valve housing 120.

The piston assembly 124 comprises a piston 150 having a head 152, shaft 154 and stem 156. The head 152 and shaft 154 each have an annular groove 158, 160 in which is received an O-ring 162, 164. An annular seal platform 168 is mounted to the piston stem 156 exterior to the dump valve chamber and supports a seal 170, preferably made of an elastomer. The seal 170 seals the inlet opening 125 of the dump valve housing 120 to stop fluid communication between the air control chamber 42 and the dump valve chamber 122. A spring 172 is axially mounted about the piston shaft 154 within the central portion 138 of the dump valve chamber 122 and is compressively retained between the piston head 152 and the stop 140 so that the seal 170 is biased against the inlet opening 125.

The piston trigger 126 is threadably mounted into the trigger opening 123 of the dump valve housing 120. The piston trigger 126 preferably has an annular ring 174, which abuts the piston head 152 to limit the outward travel of the piston 150. The piston trigger 126 also has a tapped aperture 176 extending therethrough. The piston trigger 126 is adapted to be fluidly connected to the pressurized fluid source of the vehicle so that pressurized fluid can be directed through the tapped aperture 176 and against the piston head 152 to move the piston 150 inwardly against the force of the spring 172. When the pressurized air is exhausted from the piston trigger 126, the spring 172 biases the piston 150 into contact with the annular ring 174 of the piston trigger 126. Preferably, an O-ring 178 is disposed between a portion of the piston trigger 126 and the dump valve housing 120 to seal the threads of the opening 123. Also, an O-ring 180 is disposed between the mounting bracket 56 and the dump valve housing 120 to provide a further seal.

In operation, the height control valve 10 adjusts the pressure of the air in the air springs in response to movement of the vehicle frame in the normal manner. As the vehicle frame moves with respect to the suspension member, the lever arm 100 moves accordingly, resulting in a corresponding rotation of the shaft 62. As the shaft 62 is rotated, the actuator 68

correspondingly contacts either of the stems of valves 50 or 52 to exhaust air from the air springs to the atmosphere or to add pressurized air to the air springs as required. This operation is more fully described in the previously referenced U.S. Patent applications 3,858,903, 3,884,454 and 4,726,571.

5 When it is desired to completely exhaust the air from the air springs, the dump valve assembly 18 is actuated through the piston trigger 126, which directs pressurized air through the tapped aperture 176 and into the dump valve chamber 122 where the pressurized air acts against the piston head 152. As the pressurized air meets the piston head 152, the force of the pressurized air acting over the surface area of the piston head 152 overcomes the force of the spring 172 and directs the piston 150 inwardly until the spring 172 is fully compressed against the annular stop 140 of the dump valve housing 120 (FIG. 4). Simultaneously, the seal platform 168 and the seal 170 are moved away from the inlet opening 125 of the dump valve housing to open the dump valve chamber 122 with respect to the air control chamber 42 so that the pressurized air in the air control can exit through the dump valve chamber and the ports 128 to the atmosphere. In FIG. 4, the dump valve is in the exhaust position and although the stem 156 is moved into the air control chamber 42, the O-ring 164 remains disposed above the ports 128 and will not interfere with the fluid flow from the air control chamber 42 and the ports 128.

10 In the exhaust position, the piston stem 156 is adjacent to or abuts the actuator 68 to prohibit or limit the movement of the actuator 68 so it cannot actuate the valve 52 in the inlet port 44. It is important that during the dumping of air from the air springs that the movement of the actuator 68 be prohibited or limited so that the actuator 68 cannot rotate to pressurize the air springs because as the air springs are exhausted, the vehicle frame will lower, resulting in the lever arm 100 tending to rotate the shaft 62 and move the actuator into contact with the valve 52 to fluidly connect the pressurized air source to the air spring via the air control chamber 42. If the piston stem 156 did not prohibit or limit the movement of the actuator 68 so that the actuator 68 cannot actuate the valve 52 during the dumping of the air spring, the height control valve would simultaneously try to dump the air spring and fill the air spring, placing a great burden on the pressurized air system of the vehicle.

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Once the air spring is dumped, the pressurized air is removed from the piston trigger 126 and the spring 172 moves the piston 150 from the exhaust position (FIG. 4) to the sealed position (FIG. 3) where the seal 170 seals the inlet opening 125 to the air control housing 40.

5 FIGS. 5 and 6 illustrate a second embodiment of the height control valve according to the invention. The second embodiment of the height control valve is substantially identical to the embodiment disclosed in FIGS. 1 - 4, except for the alternative dump valve 200. Therefore, like numerals are used to identify like parts, but the alternative dump valve is
10 identified with numerals beginning with 200.

The alternative dump valve 200 comprises a dump valve housing 202 that defines a dump valve chamber 204 having an outlet opening 222 and an inlet opening 224. The dump valve chamber comprises an upper portion 206 defined by threads 208, central portion 212, annular stop 214, shaft
15 portion 216, annular ledge 218, and stem portion 220.

The dump valve housing 202 further comprises a piston trigger 230. Preferably, the piston trigger 230 is a tapped aperture 232 disposed in a side of the dump valve housing 202 and is adapted to be fluidly connected to the vehicle pressurized air source. At least one port 234 extends through the
20 dump valve housing 202 and fluidly connects the dump valve chamber 204 to the atmosphere. The outlet opening 222 of the dump valve housing 202 is sealed by a threaded plug 236 which is threaded into the threads 208 of the dump valve housing 202. Preferably, an O-ring 209 or any other type of suitable seal is disposed between the plug 236 and the dump valve housing
25 202.

A piston 240 comprises a piston head 242, piston shaft 244, and piston stem 246. Annular grooves 248 and 250 are respectively disposed in the piston head 242 and piston shaft 244 and respectively receive O-rings 252 and 254. A seal platform 256 is mounted to the piston stem 246 and supports a
30 seal 258 that seals the inlet opening 224 of the dump valve housing 202 when the dump valve chamber is sealed with respect to the air control chamber 42 (FIG. 4). A spring 260 is mounted between the plug 236 and the piston head 242 and biases the piston inwardly so that the dump valve 200 is always biased by the spring to the open or exhaust position (FIG. 6).

The operation of the dump valve 200 is similar to the operation of the dump valve assembly 18, except that the piston 240 is biased toward the exhaust position, whereas the piston 150 is biased toward the sealed position. To move the dump valve to the exhaust position, pressurized air is exhausted from the piston trigger 230 and tapped aperture 232 so that the piston moves downwardly by the force of the spring 260 and the seal 258 is moved away from the dump valve inlet port 224 to fluidly connect the air control chamber 42 with the dump valve chamber 204. In the exhaust position, the end of the piston stem 246 is adjacent to or abuts the actuator 68 to prevent the rotational movement of the actuator. To close the dump valve 200, pressurized air is directed into the dump valve 200 via the piston trigger 230 or tapped aperture 232 so that the piston head 242 is urged outwardly against the force of the spring 260 to seal the dump valve 200 by moving the seal platform 256 and seal 258 into abutment with the end of the dump valve housing 202.

FIG. 7 illustrates a third embodiment of a height control valve according to the invention. The third embodiment of the height control valve is substantially identical to the embodiment disclosed in FIGS. 1-4, except for the alternative dump valve 300. Therefore, like numerals are used to identify like parts, but the alternative dump valve is identified with numerals beginning with 300.

The alternative dump valve 300 comprises a dump valve housing 302 that defines a dump valve chamber 304 having an outlet opening 322 and an inlet opening 324. The dump valve chamber 304 comprises an upper portion 306 defined by threads 308, central portion 312, annular stop 314, shaft portion 316, annular ledge 318, and stem portion 320.

The dump valve housing 302 further comprises a piston trigger 330 that is threadably mounted into the outlet opening 322 of the dump valve housing 302. The piston trigger 330 has a tapped aperture 332 extending therethrough to fluidly connect the dump valve chamber 304 with a source of pressurized air. An O-ring 334 is preferably disposed between the piston trigger 330 and the dump valve housing 302. At least one port 336 extends through the dump valve housing 302 and fluidly connects the dump valve chamber 304 to the atmosphere.

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5 A piston 340 is mounted within the dump valve housing 302 for reciprocal movement within the dump valve chamber 304. The piston 340 comprises a piston head 342 and piston shaft 344. Annular grooves 348 and 350 are respectively disposed in the piston head 342 and the piston shaft 344 and respectively receive O-rings 352 and 354. The O-ring 352 seals the portion of the dump valve chamber 304 disposed inwardly of the piston head 342 with respect to the portion of the dump valve chamber 304 between the piston head 342 and the piston trigger 330. The O-ring 350 seals the stem portion of the dump valve chamber 304 with respect to the air control chamber 42 when the dump valve 300 is in the sealed condition as illustrated in FIG. 7. The piston shaft 344 has a flat 346 that extends substantially along the longitudinal length of the piston shaft 344. A spring 360 is compressively mounted between the piston head 342 and the annular ledge 318 to urge the piston 340 outwardly toward the piston trigger 330 and into the sealed condition.

10 To move the dump valve 300 to the exhaust condition, pressurized air is directed into the dump valve chamber 302 through the threaded opening 332 of the piston trigger 330 so that the pressurized air acts on the piston head 342 to move the piston 340 inwardly against the force of the spring 360. The piston 340 will continue to move inwardly until the spring 360 is fully compressed or the piston head 342 contacts the stop 314. As the piston 340 is moved inwardly, the piston shaft 344 extends beyond the inlet opening 324 until the end of the piston shaft 344 is abutting or adjacent to the actuator 68 to prevent the rotational movement of the actuator 68. In this position, the O-ring 350 is no longer in sealing engagement with the stem portion 320 of the dump valve chamber 304 and the flat 346 extends out of the stem portion 320 and into the air control chamber 42. Thus, with the absence of the seal provided by O-ring 350, the flat 346 forms a channel between the piston shaft 344 and the stem portion 320 of the dump valve chamber 304 of the dump valve housing 302 so that air in the air control chamber 42 can pass through the ports 336 to the atmosphere via the channel between the flat 346 and the dump valve housing 302.

25 To close the dump valve 300, the pressurized air is removed from the piston trigger 330 and exhausted. The spring 360 then biases the piston 340 toward the piston trigger 330 until the piston head 340 contacts the

piston trigger 330. As the piston moves outwardly, the O-ring 350 is disposed within the stem portion 320 of the dump valve chamber 304 and forms a seal of the dump valve 304 with respect to the dump valve housing 302 to fluidly seal the air control chamber 42 with respect to the dump valve chamber 304 and the ports 336.

While particular embodiments of the invention have been shown, it will be understood, of course, that the invention is not limited thereto since modifications may be made by those skilled in the art, particularly in light of the foregoing teachings. Reasonable variation and modification are possible within the scope of the foregoing disclosure of the invention without departing from the spirit of the invention. For example, it is not necessary that the piston trigger 126 facilitate the use of pressurized air. It is within the scope of the invention for the piston trigger to comprise any type of electrical, mechanical or electro-mechanical device that can reciprocally move the piston 150. The piston trigger can easily be a solenoid actuated device that contacts the piston head 152 to move the piston 150. The piston trigger can also comprise a solenoid in combination with the piston so that by energizing the solenoid, the piston is moved directly.

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Claims

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In a height control valve for maintaining the design height of a frame relative to a suspended member, the height control valve comprising:

5 a housing mounted to the frame and having an interior chamber;
an inlet port adapted to fluidly connect the interior chamber
with a source of pressurized fluid;

a discharge port adapted to fluidly connect the interior chamber
with the atmosphere;

10 a device port adapted to fluidly connect the interior chamber
with a height control member mounted between the frame and the suspended
member wherein the height control member is expandable by pressurized
fluid;

15 a sensor operably connected to the suspended member for
sensing a change in the height of the frame relative to the suspended member;
and

20 a controller disposed within the housing and operably connected
to the sensor for prohibiting fluid communication between the device port and
the inlet port and the discharge port when the frame is at the design height
relative to the suspended member, for placing the device port into fluid
communication with the inlet port when the sensor senses a height less than
the design height, and for placing the device port into fluid communication
with the discharge port when the sensor senses a height greater than the
design height;

the improvement comprising:

25 a dump valve mounted to the housing and having a fluid
port connected to the interior chamber and to the atmosphere and a valve
element in the fluid port, the valve element being selectively movable between
a sealed condition in which the interior chamber is sealed from fluid
communication with the atmosphere through the fluid port and an exhaust
30 condition in which the housing interior chamber is in fluid communication
with the atmosphere.

2. A height control valve according to claim 1 wherein the valve element is a piston movably mounted within the fluid port for reciprocating movement between a first position where the dump valve is in the sealed condition and a second position where the dump valve is in the exhaust condition.

3. A height control valve according to claim 2 wherein the dump valve further comprises a trigger for moving the piston between the first and second positions.

4. A height control valve according to claim 3 wherein the trigger is a source of pressurized fluid connected to fluid port and the pressurized fluid moves the piston.

5. A height control valve according to claim 2 wherein the dump valve has a dump valve inlet opening through which the fluid port is fluidly connected to the interior chamber and the piston comprises a head mounted to a rod, the head is disposed within the fluid port and the rod extends from the fluid port into the interior chamber through the dump valve inlet opening; a seal is fixedly mounted to the rod to seal the dump valve opening and the fluid port with respect to the housing interior when the piston is in the first position and to fluidly connect the fluid port with the housing interior when the piston is in the second position.

6. A height control valve according to claim 5 wherein the rod prohibits the controller from fluidly connecting the inlet port to the device port when the piston is in the second position.

7. A height control valve according to claim 6 and further comprising a first valve disposed in the inlet port and a second valve disposed in the discharge port, each of the first and second valves has a stem for actuating the valves; the controller includes an actuator for actuating the first and second valves by depressing the stems; the rod is of sufficient length so that it prohibits the actuator from moving the distance necessary to depress the stem of the inlet port when the piston is in the second position.

8. A height control valve according to claim 5 wherein the seal is an elastomeric member fixedly mounted to the rod.

9. A height control valve according to claim 5 wherein the dump valve has an exhaust port fluidly connecting the fluid port to the atmosphere, whereby when the piston is in the second position, the interior chamber is fluidly connected to the atmosphere via the dump valve inlet opening, fluid port, and exhaust port.

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10. A height control valve according to claim 9 wherein the dump valve further comprises a trigger for moving the piston between the first and second positions.

11. A height control valve according to claim 10 wherein the trigger is a source of pressurized fluid connected to the fluid port and the pressurized fluid moves the piston.

12. A height control valve according to claim 11 wherein the dump valve further comprises a spring disposed within the fluid port and positioned with respect to the piston to resist the movement of the piston from the first to the second positions.

13. A height control valve according to claim 11 wherein the dump valve further comprises a spring disposed within the fluid port and positioned with respect to the piston to urge the piston from the first to the second position.

14. A height control valve according to the claim 2 wherein the piston has a flat that defines a channel that fluidly connects the interior chamber to the fluid chamber in the exhaust condition.

15. A height control valve according to claim 1 wherein the dump valve has a dump valve inlet port fluidly connecting the fluid port to the housing interior and the dump valve inlet port is on one side of the height

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5 control valve housing and the inlet port and the device port are on the other side of the inlet housing.

16. A height control valve according to claim 1 wherein the height control valve is a time-delay valve.

17. A height control valve according to claim 1 wherein the dump valve further comprises a trigger for actuating the dump valve between the sealed condition and the exhaust condition.

18. In a height control valve for maintaining the design height of a frame relative to a suspended member:

a housing mounted to the frame and having an air control chamber;

5 an inlet port adapted to fluidly connect the air control chamber with a source of pressurized fluid;

a discharge port adapted to fluidly connect the air control chamber with the atmosphere;

10 a device port adapted to fluidly connect the air control chamber with a height control member mounted between the frame and the suspended member that is expandable by pressurized fluid;

a first valve, normally closed, disposed in the inlet port with a first pin for opening the first valve;

15 a second valve, normally closed, disposed in the outlet port with a second pin for opening the second valve;

a sensor operably connected to the suspended member for sensing a change in the height of the frame relative to the suspended member;

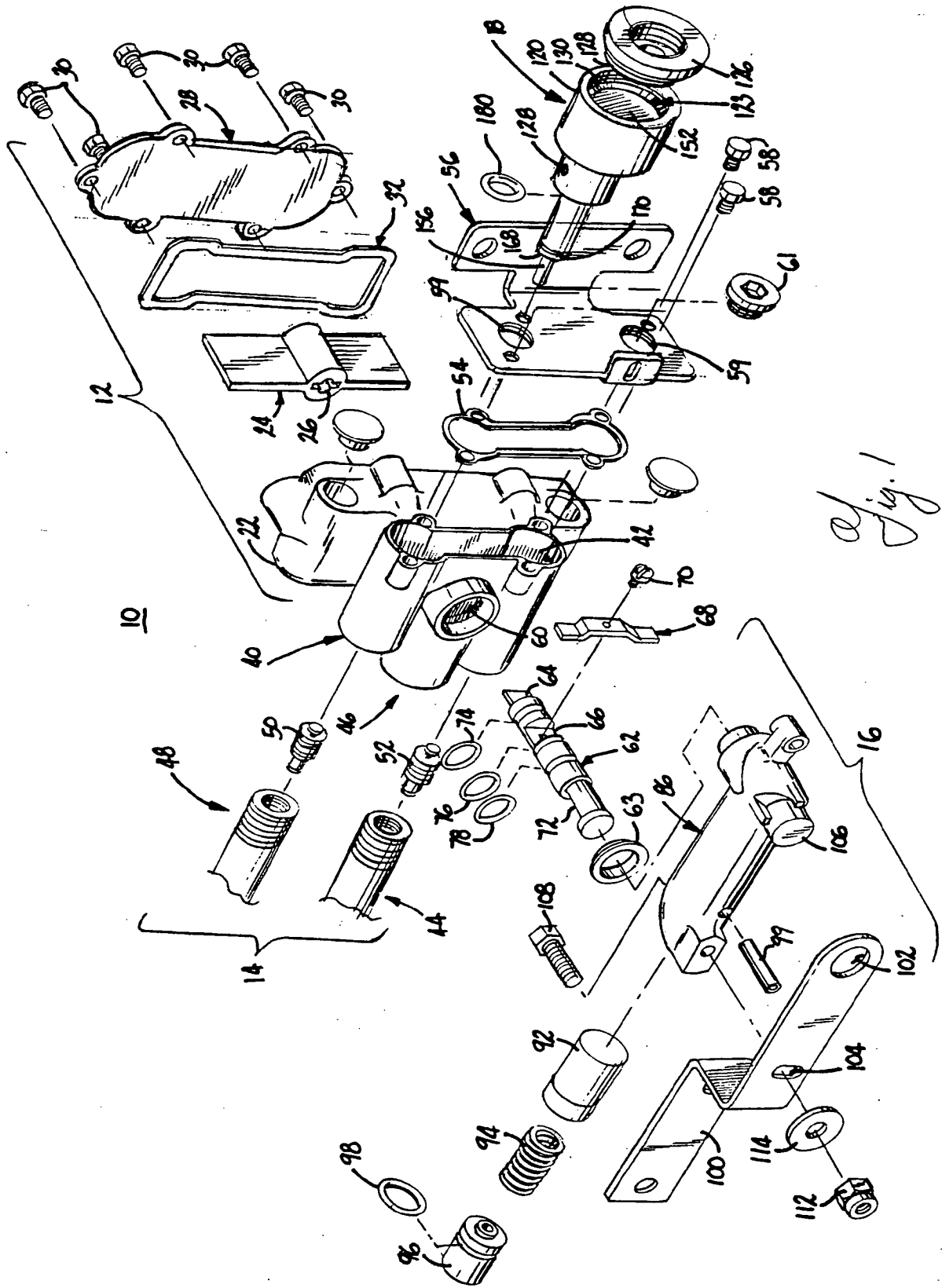
20 an actuator operably connected to the sensor and adapted to contact the first and second pin in response to the sensor and a controller to maintain the frame at the design height relative to the suspended member; and

the improvement comprising:

25 a dump valve mounted to the housing and having a fluid port connected to the interior chamber and to the atmosphere and a valve element in the fluid port, the valve element being selectively movable between

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a sealed condition in which the interior chamber is sealed from fluid communication with the atmosphere through the fluid port and an exhaust condition in which the housing interior chamber is in fluid communication with the atmosphere.



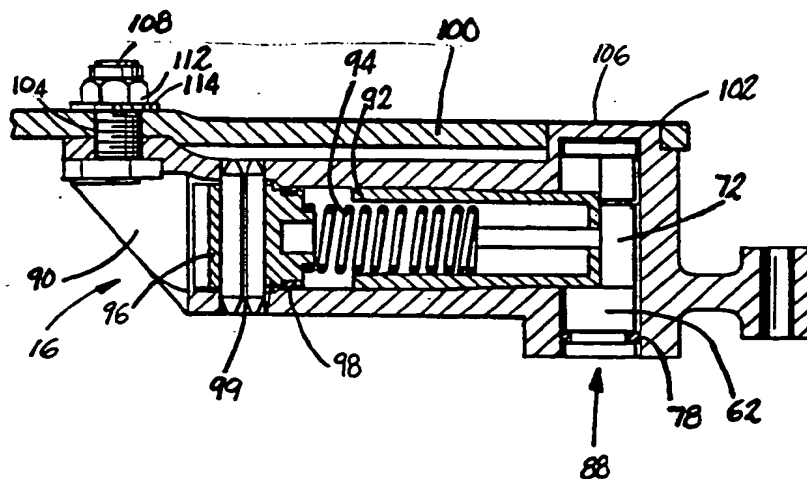


Fig. 2

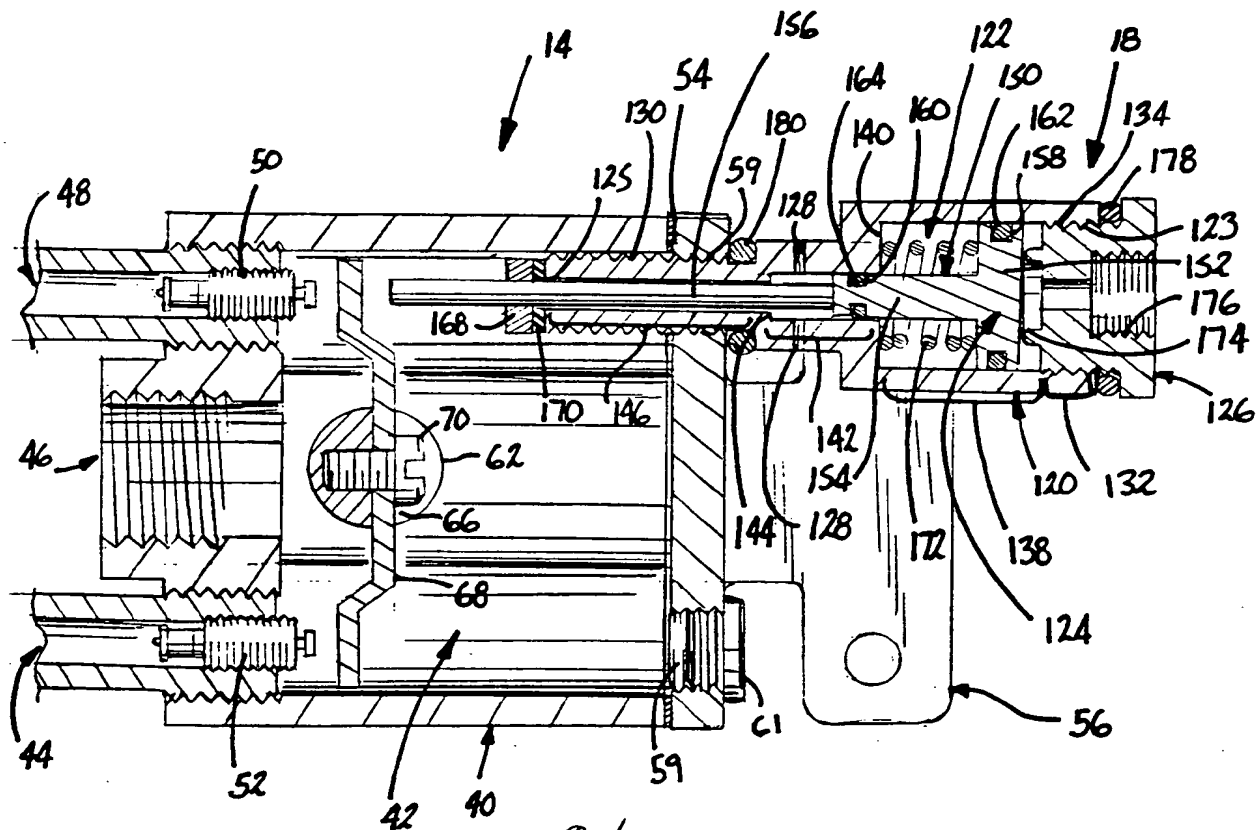
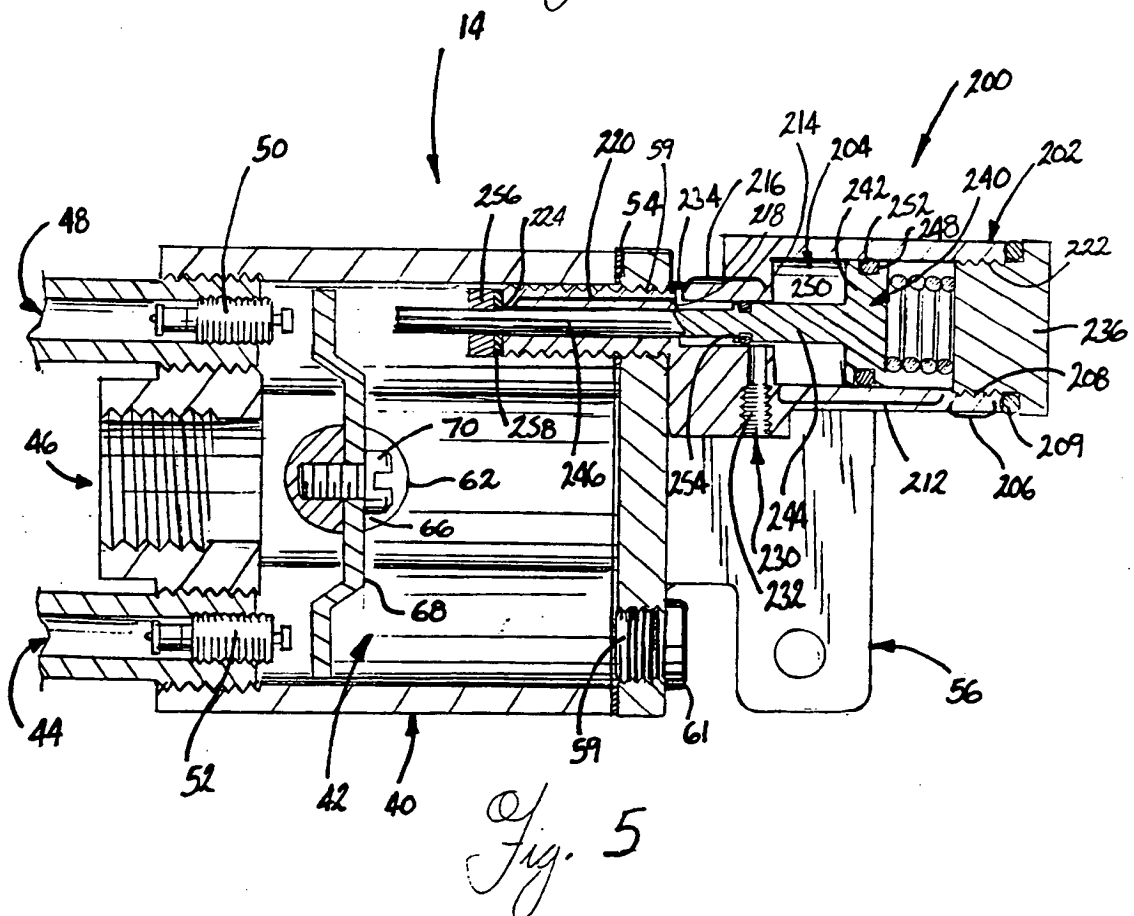
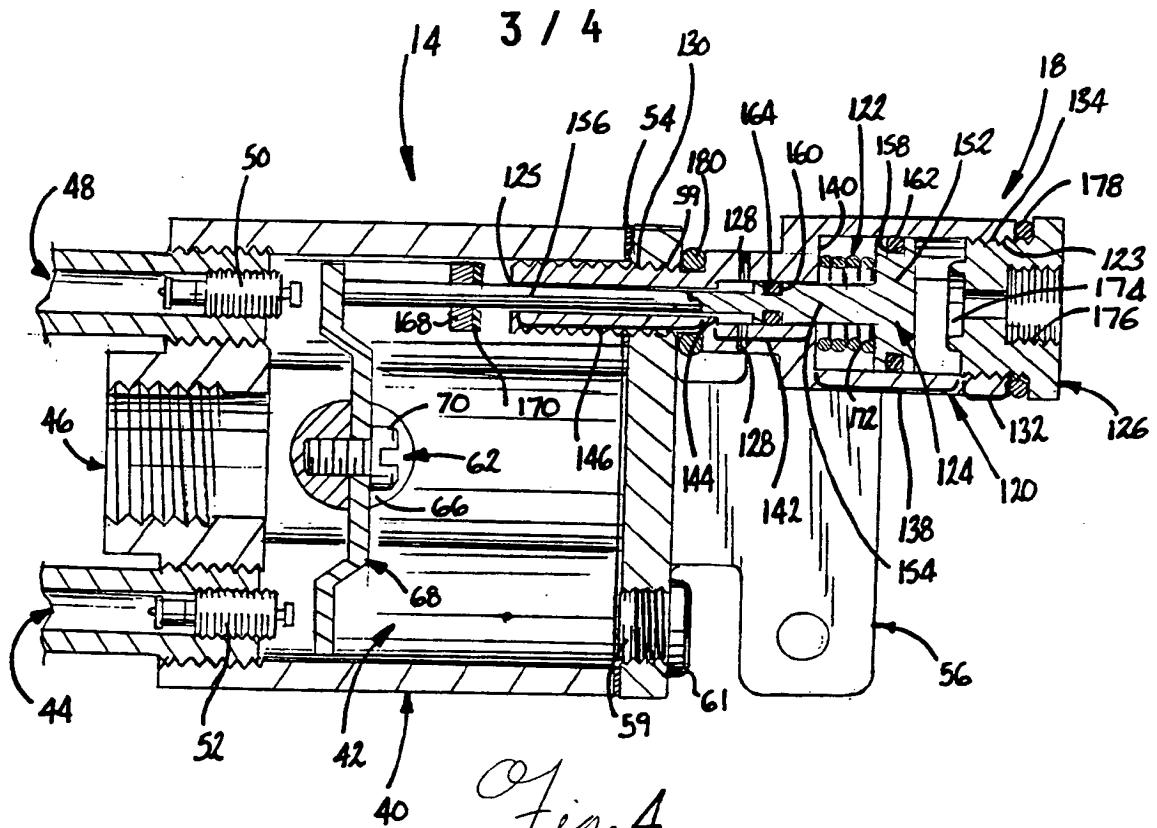


Fig. 3



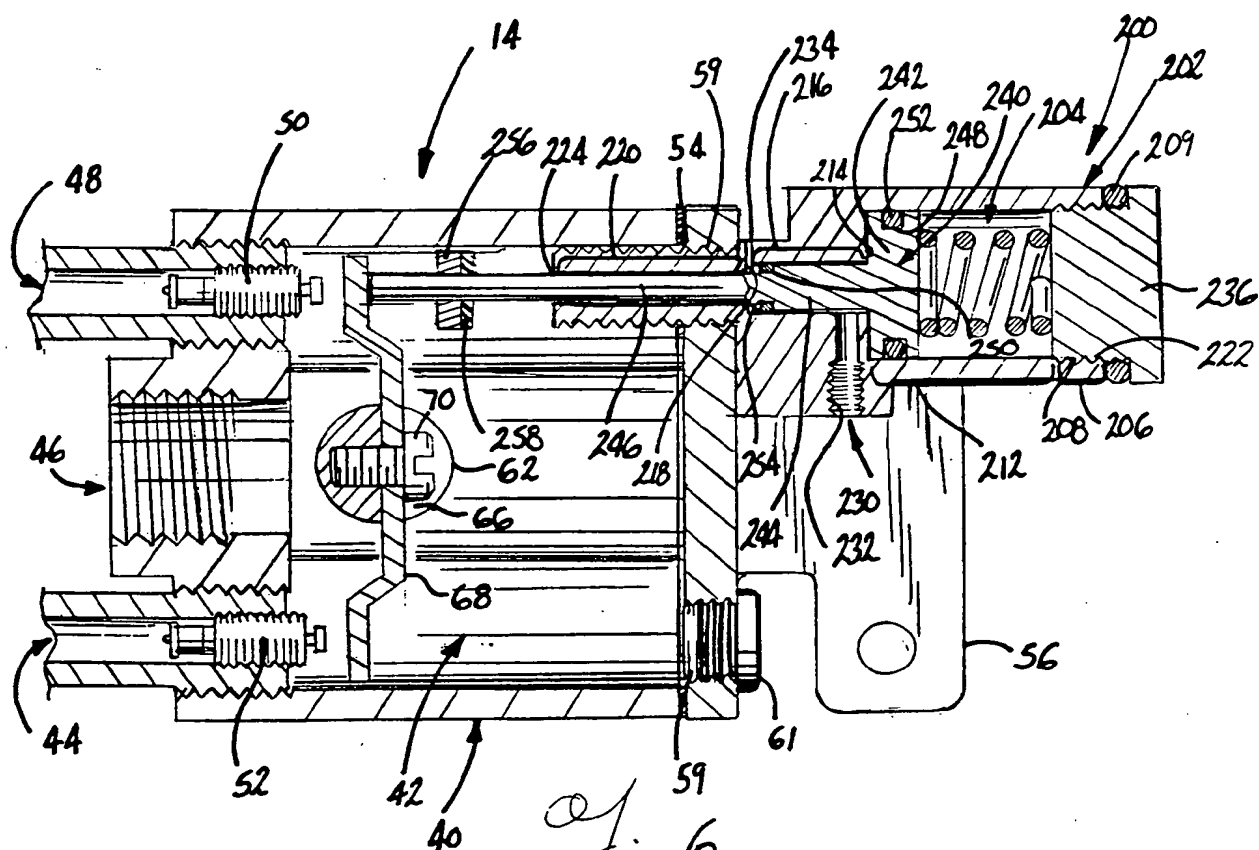


Fig. 6

INTERNATIONAL SEARCH REPORT

Internal Application No

PCT/US 94/04862

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B60G17/056

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 B60G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PATENT ABSTRACTS OF JAPAN vol. 9, no. 330 (M-442) (2053) 25 December 1985 & JP,A,60 161 207 (ISUZU JIDOSHA) 22 August 1985 see abstract ---	1,3,17, 18
A	US,A,2 919 931 (GENERAL MOTORS CORP.) 5 January 1960 see column 3, line 17 - line 39; figure 2 ---	1-3,18
A	US,A,3 884 454 (LEAR SIEGLER) 20 May 1975 cited in the application see figures ---	1,18
A	FR,A,1 201 536 (FABRICA ITALIANA MAGNETTI MARELLI) 30 December 1959 see figures 1,2 ---	
-/--		

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

2 December 1994

Date of mailing of the international search report

13.12.94

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INTERNATIONAL SEARCH REPORT

Internat'l Application No
PCT/US 94/04862

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Intern: 31 Application No

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